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# ACTA BOTANICA FENNICA

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**Timo Koponen:** The East Asiatic species of *Plagiomnium* sect. *Rostrata* (Bryophyta)



HELSINKI—HELSINGFORS
1972

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SOCIETAS PRO FAUNA ET FLORA FENNICA

# THE EAST ASIATIC SPECIES OF PLAGIOMNIUM SECT. ROSTRATA (BRYOPHYTA)

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HELSINKI — HELSINGFORS
June 1972

ISBN 951-661-003-X


## *Abstract*

KOPONEN, TIMO (Dept. Bot., Univ. Helsinki, Finland): The East Asiatic species of *Plagiomnium* sect. *Rostrata* (Bryophyta). — Acta Bot. Fennica 97:1—29. 1972.

A revision of the East Asiatic species of *Plagiomnium* sect. *Rostrata* (Kindb.) Kop. reveals that there are 6 species: *P. rostratum* (Schrad.) Kop., *P. maximoviczii* (Lindb.) Kop., *P. rhynchophorum* (Hook.) Kop., *P. integrum* (Bosch & Lac.) Kop., *P. vesicatum* (Besch.) Kop., and *P. succulentum* (Mitt.) Kop. Their diagnostic characters are compared and figured, as well as their distribution and ecology observed. Many type specimens were examined. Lectotypes are selected for *Mnium nakanishikii* Broth. and *M. rostratum* f. *laxirete* Kabiersch. The taxonomic status of *Mnium elimbatum* Broth., *M. excurrens* Par. & Broth., *Mnium integro-radiatum* Dix., *M. javense* Fleisch., *M. kawadei* Okam., *M. luteo-limbatum* Broth., *M. micro-ovale* C. Müll., *M. nietneri* C. Müll., *M. spathulifolium* Dix. and *M. subintegrum* Cardot is discussed.


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## Contents

# I. Introduction

The principal difficulty in recognizing the species of *Plagiomnium* sect. *Rostrata* seems to be in distinguishing their plagiotropic stolons. Well developed stems bearing sporophytes or archegonia and antheridia can usually be determined without hesitation, but the variability found in sterile shoots, at first sight, seems to overlap. This apparent variability possibly led many earlier bryologists to describe a great number of taxa, many of which are based only on sterile material. BROTHERUS (1924), for example, lists 20 Asiatic species but KABIERSCH (1936) reduced many of them to synonyms, recognizing 12 species and 4 infraspecific taxa. NOGUCHI's (1952) opinion of only 4 species and 2 varieties is certainly reasonable, especially when one observes that he excluded *P. maximoviczii* from his treatment. NOGUCHI (1952) reduced some of the species described by SAKURAI (1935a; 1935b; cf. also SAKURAI 1954) to synonomy. The taxonomy of *P. rostratum* and related Asiatic taxa has been discussed by FLEISCHER (1904), DIXON (1914; 1930), REIMERS (1931), HORIKAWA & ANDO (1964), IWATSUKI & SHARP (1968); cf. also ANDERSON (1954).

The results presented in this paper form a part of a monograph of the family *Mniaceae* (cf. e.g. KOPONEN 1968; 1971a) so that the present paper is preliminary to some extent. For instance, in the lists of synonyms only those names are listed whose types were available, or which can be concluded to be synonyms on the basis of published figures or earlier studies, especially those by KABIERSCH (1936). The distribution of each taxon is only briefly discussed since it is hoped that more complete information of them, especially in Japan and Taiwan, will be available to be published later. I also hope to have more precise descriptions of the taxa which now will be compared in a table and provided with figures and discussions.

The material used consists of the collections made by the present author in Japan and Taiwan during 1970—1971, and the specimens in the herbaria of the Hattori Botanical Laboratory (NICH) and Botanical Institute, Faculty of Science, University of Hiroshima (HIRO). In addition, type specimens and material for comparison were received from BM, H, L, MAK, NY, and TNS (abbreviations according to LANJOUW & STAFLEU 1964), as well as the private herbaria of Dr. Akira Noguchi (Kumamoto), Dr. Noriwo Takaki (Nagoya), Dr. Toshio Shin (Kagoshima), and Dr. Satoshi Nakanishi (Kobe).

In the course of the present research, special attention was paid to the sterile shoots. A useful method proved to be to study plagiotropic shoots originating from the base of fertile female or male stems (cf. Figs. 9, 13, 14; 30, 31; 42, 49, 43, 52; 66, 67). The limits of

variation for each species could be checked with certainty using the shoots, and the experience thus gained could be used for determining specimens composed merely of these sterile shoots. It is obvious that if the six taxa, here treated as species, are accepted,then also the phytogeographical and ecological observations made can be satisfactorily explained.

## II. Taxonomic characters used

### *Sexuality*

Different opinions have prevailed about the usefulness of the sexuality as a taxonomic character in the *Mniaceae*. BROTHERUS (1924) seems to have accepted it as one of the main criteria, while KABIERSCH (1936) held the opinion that the synoecism and dioecism cannot be used in separating species. Accordingly, KABIERSCH accepted only subspecific rank for *Plagiomnium trichomanes*, as does NOGUCHI (1960), who treats the taxon as a variety. The genetic explanation of the dioecious and synoecious »species pairs» was discovered by LOWRY (1948). Synoecious species have the diploid chromosome number in the gametophyte in comparison to the haploid number in the dioecious counterpart (however, see BOWERS 1969). Although criticism has been presented (KOPONEN 1967; 1971c; BOWERS 1968) on the correctness of the species pairs selected by LOWRY (1948), these commonly have been accepted as an example of speciation in mosses. Besides the difference in the sexuality there seems to be rather few characters which can be used in separating the counterparts of these species pairs from each other. Plant size appears to be one of them. The synoecious species seem to be larger. This is most clearly observed in the size of laminal cells and leaf shape. There is, however, one character which can be readily observed if male plants are present. The male plants are morphologically different from female plants of the same species and from the fertile stems of the synoecious counterpart. The »species pairs» seem to have similar ecological requirements but at least some of the synoecious species have a larger distribution range than their dioecious counterparts. This fits well to the pairs *Plagiomnium insigne* — *P. medium* and *P. trichomanes* — *P. cuspidatum* among which the synoecious species have a circumpolar range but the dioecious species shows a more limited distribution (cf. BOWERS 1966; 1968; KOPONEN 1971c). The fact should be emphasized that the ranges often seem to be partly overlapping. The present author holds the opinion that the members of these dioecious — synoecious species pairs fill all the requirements of a »good» species, i.e., they have taxonomic characters although slight, by which they can be separated, they have a distinct distribution which can be explained by commonly accepted phytogeographical hypotheses, and they maintain themselves in nature (cf. BOWERS 1968) which is evident through their partly overlapping

ranges. The only reason why they could not be accepted as species is merely practical; the specimens composed of only sterile shoots and originating from the areas where both of the taxa are present may be difficult to determine. On the basis of the above discussion, the sexuality is a very useful and reliable taxonomic character in the *Mniaceae*.

Among the taxa now under treatment there seems to be one »species pair», *P. maximoviczii* — *P. rhynchophorum*. The chromosome number of *P. rhynchophorum* is not known but *P. maximoviczii* has the haploid number, 7 (e.g. TATUNO & ONO 1966). However, there is a possibility that the synoecious counterpart of *P. maximoviczii* could be some other synoecious species than *P. rhynchophorum* (cf. ANDERSON 1954).

### *Growth habit and size*

Within the genus *Plagiomnium* the Asiatic species of the section *Rostrata* are small to medium sized. The height of the stems bearing archegonia or antheridia is 1—3 cm in most cases. Submerged stems of *P. vesicatum* may reach a height of 5 cm. All the species have plagiotropic stolons completely adpressed to the substratum and »rooting» with numerous rhizoids. The leaves of the sterile stolons of *P. succulentum* are often perpendicular against an upright cliff face or side of stone. The leaves are also characteristically shiny, thereby making this species easy to recognize in the field.

### *Leaf characters* (Table 1).

On the basis of the leaf shapes, *P. maximoviczii* and *P. rhynchophorum* can be separated from the other four East Asian species by having often oblong, undulate leaves. *P. succulentum* has the widest leaves, which are elliptic to broadly elliptic, while the leaf shape of *P. rostratum*, *P. integrum* and *P. vesicatum* is rather similar, being elliptic to narrowly elliptic. The leaves of *P. vesicatum* are usually larger than those of *P. rostratum* and *P. integrum*. The leaves on sterile stolons tend to be shorter and wider than on fertile stems. All the species have leaves with definitely decurrent leaf bases, except *P. rostratum* and *P. succulentum*. The border is well differentiated in all species except *P. succulentum*, being composed of 3—5 rows of linear cells. Marginal teeth of more than one cell occur in all species but *P. rostratum*. These teeth can be used as a taxonomic criterion although the character is not always reliable when making determinations (cf. KOPONEN 1967; 1971c). The maximum development of teeth occurs in *P. rhynchophorum* and *P. maximoviczii*, which sometimes have teeth formed by three cells. Laminal cells offer several characters, such as shape, size and differences in wall thickening (Table 1). The

TABLE 1. A comparison of the diagnostic characters of *P. rostratum* and its relatives. All the measurements and observations were carried out by using fertile synoecious or female stems.

| | *maximoviczii* | *rhynchophorum* | *rostratum* |
|---|---|---|---|
| sexuality | dioecious | synoecious | synoecious |
| chromosome number | n = 7 | — | n = 12 |
| leaf shape | oblong to narrowly elliptic | oblong to narrowly elliptic | elliptic to narrowly elliptic |
| leaf size, mm | 1.2—2.8 × 3.2—7.3 | 1.6—3.3 × 3.6—9.1 (—13.0) | 1.9—3.6 × 3.3—7.3 |
| leaf apex | obtuse to emarginate | obtuse to emarginate | obtuse to emarginate |
| leaf base | decurrent | decurrent | not or shortly decurrent |
| costa, surface view | conspicuous, percurrent, outermost guide cells easily visible | conspicuous, percurrent, guide cells visible | conspicuous, percurrent, guide cells similar to laminal cells |
| costa, shape of cross-section | often rather rounded | often rather rounded | elliptic |
| costa, cells of dorsal part | much incrassate | much incrassate | moderately incrassate |
| costa, cells of ventral part | much incrassate | much incrassate | much incrassate |
| shape of laminal cells | quadrate to rectangular, or hexagonal, elongated | quadrate to rectangular, or elongated hexagonal | isodiametric to elongated, hexagonal |
| size of laminal cells, μm | 7—17 × 12—27 | 10—25 × 15—42 | 20—32 × 27—50 |
| walls of laminal cells | mostly much incrassate, clear corner thickenings | slightly incrassate, clear corner thickenings | thin-walled, clear corner thickenings |
| laminal cells in cross-section | mostly not mamillate | mostly not mamillate | slightly mamillate |
| leaf border | 3—5 cells wide, conspicuous | 3—5 cells wide, conspicuous | 4—5 cells wide, conspicuous |
| marginal teeth | 1—2 (-3) -celled, projecting, rarely absent | 1—2 (-3) -celled, projecting, rarely absent | 1 -celled, mostly not projecting, rarely absent |
| length of seta, cm | 2.7—3.9 | 1.9—2.6 (-3.6) | 1.3—3.5 |
| length of capsule, mm | 2.0—3.3 | 2.0—3.1 | 1.5—2.6 |
| degree of polysety | 1—4 | 1—7 | 1—6 |

basic structure of the costa is similar in all the species but there are differences in the size and thickening of the epidermal layers. In well-developed leaves of *P. maximoviczii* and *P. rhynchophorum*, both ventral and dorsal epidermal layers are with thickened walls, while in *P. succulentum* and *P. vesicatum* the dorsal layer is composed of large thin-walled cells. The laminal cells in cross-

| | *integrum* | *vesicatum* | *succulentum* |
|---|---|---|---|
| sexuality | dioecious | dioecious | dioecious |
| chromosome number | — | n = 7 | n = 7 |
| leaf shape | elliptic to narrowly elliptic | elliptic to narrowly elliptic | elliptic to broadly elliptic |
| leaf size, mm | 1.9—4.8 × 3.9—7.5 | 2.3—4.0 × 4.4—7.5 | 2.5—6.0 × 4.6—14.0 |
| leaf apex | obtuse to emarginate | mostly obtuse | mostly obtuse |
| leaf base | decurrent | decurrent | not decurrent |
| costa, surface viewz | narrow, percurrent, guide cells similar to laminal cells | conspicuous, mostly percurrent, guide cells similar to laminal cells | unconspicuous apically, mostly not percurrent, guide cells not visible |
| costa, shape of cross-section | elliptic | rounded to elliptic | flattened |
| costa, cells of dorsal part | moderately incrassate | mostly with thin valls | mostly with thin walls |
| costa, cells of ventral part | much incrassate | moderately incrassate | moderately incrassate |
| shape of laminal cells | mostly elongated, hexagonal | mostly elongated, hexagonal | elongated, hexagonal |
| size of laminal cells, $\mu$m | 17—45 × 32—65 | 27—45 × 37—90 | 33—70 × 55—120 |
| walls of laminal cells | mostly incrassate, corner thickenings present | thin-walled, with or without corner thickenings | thin-walled, or slightly incrassate, corner thickenings mostly absent |
| laminal cells in cross-section | slightly mamillate | slightly mamillate | slightly mamillate |
| leaf border | 2—4 cells wide, smaller | 4—6 cells wide, conspicious | 0—3 cells wide, unconspicuous |
| marginal teeth | 1 (-2) -celled, projecting, entire leaves exist | 1 (-2) -celled, projecting, entire leaves common | 1—2 (-3) -celled, projecting, entire leaves exist |
| length of seta, cm | — | 2.0—3.6 | 2.2—3.6 |
| length of capsule, mm | — | 2.0—3.0 | 1.7—5.8 |
| degree of polysety | — | 1—5 | 1—3 |

section are slightly mamillate in all species but *P. maximoviczii* and in most cases in *P. rhynchophorum*. The costa reaches the apex in the leaves of all species but *P. succulentum*. In *P. vesicatum* there often are several thick-walled cells between the end of the costa and the border. The leaves of the stolons are, however, more variable in this respect.

*Sporophyte*

The fact that the dioecious species rarely bear sporophytes prevented a closer study of them. However, differences in the length of seta and capsule were recorded (Table 1), although the degree of overlapping is rather great. All the species are polysetose and have a rostrate operculum. The stomata are distributed throughout the capsule which is a sectional character and could be checked for all the species but *P. integrum*.

## III. Taxa

### *Plagiomnium rostratum* (Schrad.) Kop.

(Figs. 1—7)

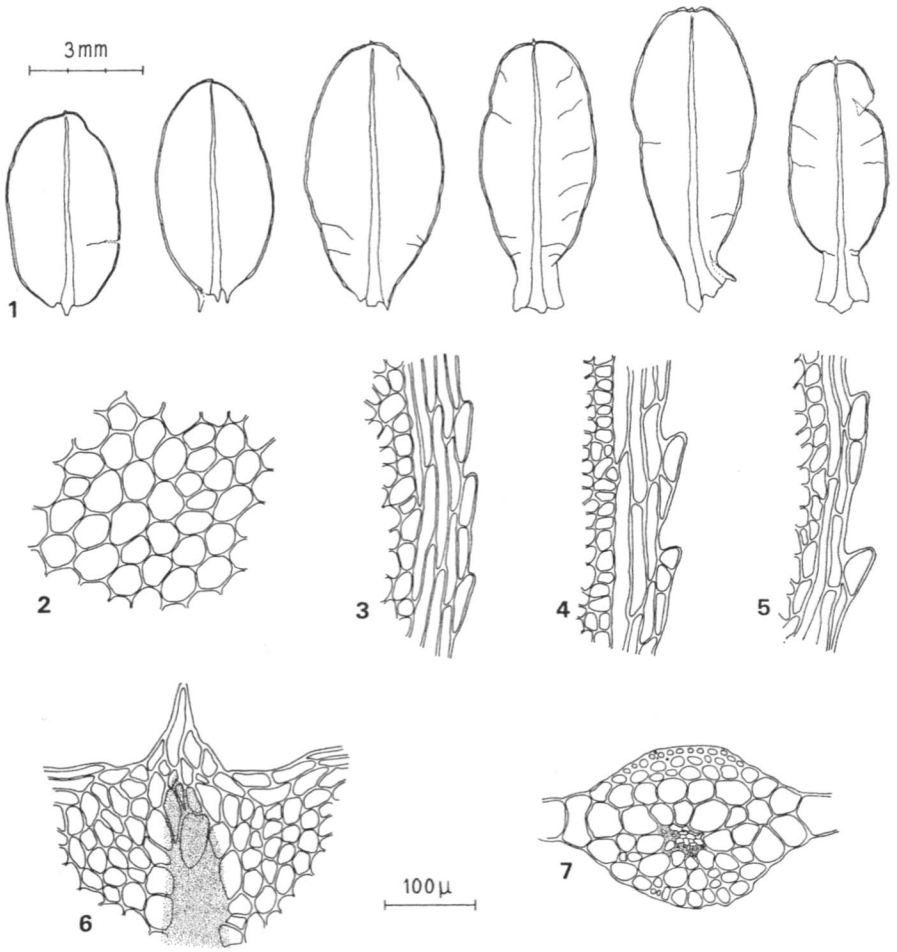
*Plagiomnium rostratum* (Schrad.) Koponen, Ann. Bot. Fennici 5: 147. 1968. — *Mnium rostratum* Schrader, Bot. Zeit. Regensburg 1: 79. 1802. — Typification: Cf. FLORSCHÜTZ 1964; type specimen not seen.

*Mnium longirostre* Bridel, Muscol. Rec. 2 (3): 106. 1803. — Type: not seen.

*Taxonomy*

The diagnostic characters of *P. rostratum* are its synoecity, leaves are not decurrent or only very shortly decurrent, and the marginal teeth are not projecting and always formed by only one cell. The laminal cells possess clear corner thickenings and the cells tend to be isodiametric, although elongated cells occur in every leaf. Among the taxa now under discussion, *P. rostratum* can be confused with *P. integrum* and *P. vesicatum*, but the latter two species are dioecious and are therefore easily separated in fertile condition. The other differences separating these two taxa from *P. rostratum* are their definitely decurrent leaf bases, usually larger and rather regularly elongated laminal cells, and more prominent projecting teeth. The teeth character, however, can not always be used, especially in the case of sterile shoots. The characters separating *P. rostratum* from *P. maximoviczii*, *P. rhynchophorum* and *P. succulentum* are discussed in connection with these taxa.

The European populations of *P. rostratum* are rather unvariable and the measurements in Table 1 are mainly based on European material. The Asiatic specimens studied until now are too few to allow any detailed discussions. However, the leaf shape and size, and cell characters, as well as the shape of marginal teeth fit the European material rather well.




FIGS. 1—7. *Plagiomnium rostratum*. 1 = leaf spectrum. 2 = laminal cells. 3, 4 = leaf border 5 = leaf border near apex. 6 = leaf apex. 7 = cross-section of costa (all figures from Finland, Ta. Hattula, Nikkilä. 1908, Rancken & Wegelius, H). — All figures in this paper were drawn from fertile (female) stems if not otherwise stated. The laminal areolation was drawn at the centre of laminal halves, and the border in the central part of the leaf, if not stated otherwise.

### *Distribution and ecology*

*Plagiomnium rostratum* has been considered in a rather broad sense by most authors who commonly list it as an example of a cosmopolitan moss. However, if only European populations are considered, it may be stated that it is limited mainly to temperate and hemiboreal zones (terminology according to AHTI et al. 1968). On the basis of field experience in North Europe the author is certain that it is very rare in boreal zones and seems to be completely absent

from orohemiarctic and oroarctic zones (cf. also NYHOLM 1958). Moreover, in its northernmost localities it is rather clearly dependent on the presence of limestone, and many of the labels on herbarium specimens from temperate zones indicate limestone or calcareous soil as the substrate. On occasion the species does occur on the bases of broad-leaved trees. From North America the author has seen material both from the east (New York and Michigan) and the west (New Mexico, Wyoming, Montana, Oregon, Washington, and British Columbia). Herbarium studies also have revealed that *P. rostratum* commonly has been confused with *P. ellipticum* which has a wide boreal circumpolar range (KOPONEN 1971c). Thus, the distribution area of *P. rostratum* evidently has a rather definite northern boundary.

BROTHERUS (1924) lumped a large number of species described from tropical and subtropical districts under *P. rostratum*. As far as tropical Asia is concerned he followed FLEISCHER (1904). On the basis of the results of the present study, *P. rostratum* in Asia has a rather limited range (cf. below). At this time it can be reported that the specimens studied from tropical districts other than Asia represent taxa that are different from *P. rostratum* s. str. (cf. also ANDERSON 1954). In conclusion, *P. rostratum* s. str. seems to have a discontinuously circumpolar temperate distribution pattern.

During this research, Asiatic specimens were seen only from the Himalayas and Yunnan. However, the material seen from China was rather scanty and I have not yet studied the Siberian material. Specimens of *P. rostratum* from Japan have not been seen, although it has been reported frequently from there (e.g. SAKURAI 1935a; KABIERSCH 1936; Noguchi 1952). The specimens seen in herbaria under that name are mostly typical *P. vesicatum* or small forms of *P. vesicatum* with laminal cells rather similar to *P. rostratum* (p. 21) and small forms of *P. maximoviczii* with elliptic leaves and isodiametric laminal cells (p. 12).

Asiatic specimens examined:
India. N. W. Himalaya: Sine loco, leg. Royle (BM), leg. Falconer (NY); Simla, leg. Beddome 2 (NY); Dehra-Dun, Sansidàra, 2—3000', 1891 Duthie (Bryotheca E. Levier, det. C. Müller sub. no 565, NY); Tehri-Garhwal Distr., Deota Valley, 7—8000 ft., 1899 Duthie (NY).
China. Yunnan, leg. Delavay (NY).

## *Plagiomnium maximoviczii* (Lindb.) Kop.

(Figs. 8—19)

*Plagiomnium maximoviczii* (Lindb.) Koponen, Ann. Bot. Fennici 5: 147. 1968. — *Mnium maximoviczii* Lindberg, Acta Soc. Scient. Fennicae 10: 224. 1875. — Holotype: Japonia. Yokohama, 10—22.VI.1962 Maximovicz (H-SOL).
*Mnium micro-ovale* C. Müller, Nuovo Giorn. Bot. Italiano, N. Ser. 4, 3: 246. 1897. — *Mnium rostratum f. micro-ovale* (C. Müll.) Kabiersch, Hedwigia 67: 46. 1936. — Syntype:

China interior, prov. Schen-si sept., Fu-kio, 1895 J. Giraldi (Bryotheca E. Levier, det. C. Müller sub. no. 1498, H-BR).

*Mnium subundulatum* Dixon ex Kabiersch, Hedwigia 67: 58—59. 1936. — Holotype: Japan. Kiushiu. Prov. Hissen, Mt. Kurogami, on ground, 3.V.1923 K. Yamashita (= herb. Sasaoka no. 5123, BM; isotype in TNS).

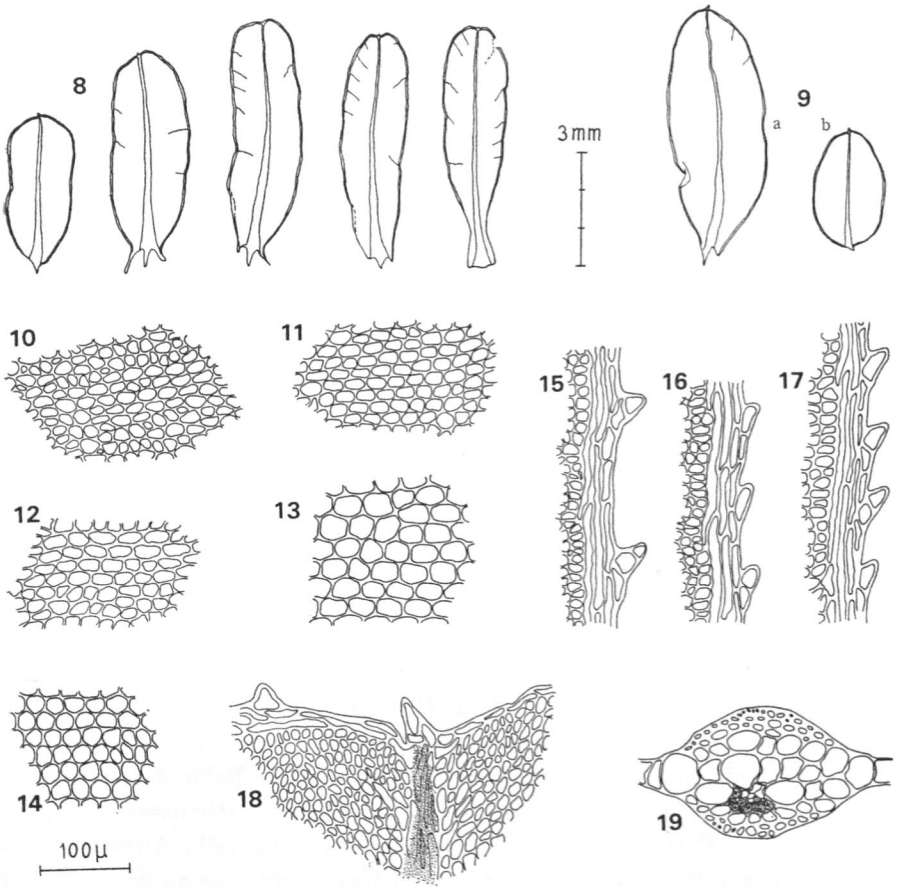
*Mnium Maximoviczii* var. *angustilimbatum* Dixon, Rev. Bryol. 1: 182. 1928. — Holotype: China. Chensi Central, Wei tze p'ing, 14, XIII. 1916. E. Licent (BM).

*Note.* According to KABIERSCH (1936) *Mnium yunnanense* Thér. and *M. spathulatum* Mitt. are conspecific with *P. maximoviczii*.

The syntype of *Mnium micro-ovale* is composed of male plants of *P. maximoviczii* and depauperate stolons of the same species. There are four other syntypes which were not seen.

## *Taxonomy*

The closest relative of *P. maximoviczii*, among the species under discussion, is *P. rhynchophorum*. Many characters, such as oblong, undulate leaves, shape of laminal cells, ability of marginal teeth to be formed even by three cells, and the similar shape of the costa in cross-section, connect them and separate them from the other species. The large cells visible at the side of the costa in the surface view of the lamina (= the outermost »guide» cells in crosssection), which have been used as a diagnostic character for *P. maximoviczii*, are present also in *P. rhynchophorum* and the other species as well. However, since the ordinary laminal cells are small in *P. maximoviczii* and *P. rhynchophorum* these cells are more clearly visible in these species and can be used in separating them from their relatives. The character is not always reliable in depauperate forms. In addition to the difference in the sexuality, *P. maximoviczii* can be separated from *P. rhynchophorum* by the smaller laminal cells. Although basically hexagonal, the laminal cells in both of species give one an impression of being rectangular or quadrate. The laminal areolation is more regular in *P. rhynchophorum* than in *P. maximoviczii* which has large cells and smaller cells in more irregular order. The length of the cells varies but the width tends to be rather stable for each lamina. For the determination of herbarium specimens it can be roughly stated, that in the central lamina of *P. maximoviczii* there are no or only a few cells longer than 25 $\mu$, while such cells are numerous in the corresponding part of *P. rhynchophorum*. Laminal cells in *P. maximoviczii* seem to be more incrassate than in *P. rhynchophorum*. In general, *P. maximoviczii* is smaller than *P. rhynchophorum*, e.g., the leaves are narrower but this cannot be used in determining specimens due to a large degree of overlap. The seta is longer and the capsule larger in *P. maximoviczii*, although these characters to some extent depend on the vitality of the plant and on the degree of the polysety. Well developed sterile stolons of *P. maximoviczii* retain the leaf characters of the fertile stems described above. Only very small and depauperate leaves are completely without teeth.




FIGS. 8—19. *Plagiomnium maximoviczii*. 8 = leaf spectrum. 9a, b = leaf shapes. 10, 12 — 14 = laminal cells. 11 = laminal cells near the apex. 15, 16 = leaf border. 17 = leaf border near apex. 18 = leaf apex. 19 = cross-section of costa. — Figs. 9a and 9b from upright stem and the stolon of the same female plant, Figs. 13 and 14 show their laminal areolation, respectively. — Figs. 8, 10, 11, 16—18 from the type of *P. maximoviczii*. — Figs. 9, 13, 14 from Takaki 17536 (Japan, Mt. Kiso-ontake). — Figs. 12, 15 and 19 from the type of *Mnium subundulatum*.

The only other taxonomic difficulty in *P. maximoviczii*, in addition to its separation from *P. rhynchophorum*, is in some forms which have narrowly elliptic leaves with isodiametric laminal cells (Figs. 9, 13, 14). The specimens, mostly determined as *Mnium rostratum*, originate from rather dry localities, such as limestone cliffs or bases of trees. *Mnium micro-ovale* C. Müll. (cf. above) possibly represents this type.

*Distribution and ecology*

The range of *P. maximoviczii* extends from Japan through Korea and Taiwan to west of China. In Japan, it is common in temperate zones and occurs scattered up to the lower oroboreal zone. In Taiwan, the altitudinal limits recorded are 1200—2600 m and roughly correspond to the altitudinal distribution in Japan. The records of the species from the Himalayas need confirmation. *P. maximoviczii* preferably inhabits mesic sites in woodlands, such as stones covered by soil or humus, rotten wood and cliff walls. It is influenced by human activities and grows at trail sides on soil, stone walls, and in gardens.

Specimens seen from outside Taiwan and Japan:

China Prov. Schen-si sept., in monte Tui-kio-san, 1896 Giraldi (Bryotheca E. Levier, det. C. Müller as *Mnium micro-ovale* sub. no. 2155, H-BR).

Korea. Mt. Hanra, on rocks, 1300 m, 1960 Hong 11511 (NICH); Mt. Sokri, 500 and 550 m, 1960 Hong 2772, 2777 (NICH); Mt. Chii, 600 m, 1960 Hong 2063 (NICH); Mt. Chiak, 420, 460 and 820 m. 1961 Hong 5803, 5794, 5802 (NICH).

Musci Japon. exs. 168, 716, 790 and 929.

## *Plagiomnium rhynchophorum* (Hook.) Kop.

(Figs. 20—29)

*Plagiomnium rhynchophorum* (Hook.) Koponen, Hikobia 6: 57. 1971. — *Mnium rhynchophorum* Hooker, Icon. Plant. Rar. 1, Tab. 20, Fig. 3. 1836 [and Hooker ex Harvey in Hooker, J. Bot. 2: 11. 1840]. — *Mnium longirostre* var. *rhynchophorum* (Hook.) Wijk & Margadant, Taxon 8: 106. 1959. — Type: Cf. KOPONEN 1971b, and below.

*Bryum coriaceum* Griffith, Calcutta J. Nat. Hist. 3(9): 60. 1842. — *Mnium coriaceum* (Griff.) Mitten, J. Linn. Soc. Bot. Suppl. 1: 143. 1859. — *Mnium rostratum* var. *coriaceum* (Griff.) Paris, Ind. Bryol. 834. 1897. — *Mnium longirostre* var. *coriaceum* (Griff.) Wijk & Margadant, Taxon 8: 74. 1959. — *Mnium rostratum* f. *coriaceum* (Griff.) Kabiersch, Hedwigia 67: 46. 1936. — Holotype: In rupibus humidis Mamloo copiose, leg. Griffith (BM, isotype in NY).

*Mnium nietneri* C. Müller, Linnaea 36: 32. 1896. (Cf. below).

*Mnium rostratum* β [var.] *Javanicum* Nees ex Wilson, Bryol. Britt. 255. 1855. — Holotype: '*Mnium rostratum* β *javanicum* Nees' sine loco, Herb. Musc. W. Wilson no. 2500 (BM).

*Note.* As discussed by KOPONEN (1971b) there is no specimen in Hooker's herbarium which could be selected as the type of *Mnium rhynchophorum*. On the basis of the information by Dr. C. C. Townsend (Royal Botanic Gardens, Kew) there is a specimen in Wallich's herbarium (in K) labelled as »*Bryum rhynchophorum*, Penang, Wallich 7594». HARVEY (in HARVEY & HOOKER 1840) who actually introduced the description of the taxon, gives the source of the name as »*M. rhynchophorum* Hook. in Wall. Cat. n. 7594». However, I was not yet able to study this specimen.

On the basis of the reference in the protologue to MITTEN (1859) the type specimen of *Mnium nietneri* could be Gardner no. 671 from Ceylon (not seen). However, in H-BR there is a specimen from Ceylon which possibly originates from C. Müller's herbarium (p. 16). It is typical *P. rhynchophorum*.

### *Taxonomy*

*P. rhynchophorum* was reduced as a synonym of *P. rostratum* by FLEISCHER (1902—1904) and BROTHERUS (1924), who followed FLEISCHER's concept. KABIERSCH (1936) did not find any differences between *P. rostratum* and *P. rhynchophorum*, either. KABIERSCH's treatment is possibly due to the fact that he incorrectly placed *P. maximoviczii* in the section *Undulata* (cf. also ANDERSON 1954) and thus the relationship of *P. rhynchophorum* and *P. maximoviczii* escaped notice. It may be emphasized that HORIKAWA & ANDO (1964), when discussing the taxonomy of *P. maximoviczii*, discovered the diagnostic characters of *P. rhynchophorum*. The taxonomy of *P. rhynchophorum* is discussed in connection with *P. maximoviczii* above. The sterile stolons of *P. rhynchophorum* can be determined without hesitation in most cases. The cell size in leaves from stolons exceeds that in fertile leaves. Some stolons possibly grow in wet habitat so that the leaves are much wider than usual. Marginal teeth are mostly well developed on leaves from stolons.

Most part of the material seen was easily determined. Some tiny forms with elliptic leaves and rather isodiametric laminal cells made me hesitate. These specimens mostly originate from the Himalayas. Specimens were synoecious but the cell size is much smaller than in *P. rostratum* and it was finally concluded that they belong to *P. rhynchophorum*. From the Philippines and Java some exceptionally large plants were seen with leaves up to 1.3 cm long in which also the size of laminal cells much exceeds the average. The material studied from these areas is too scanty for deciding whether they represent a separate taxon or are merely a modification growing on exceptionally wet habitats.

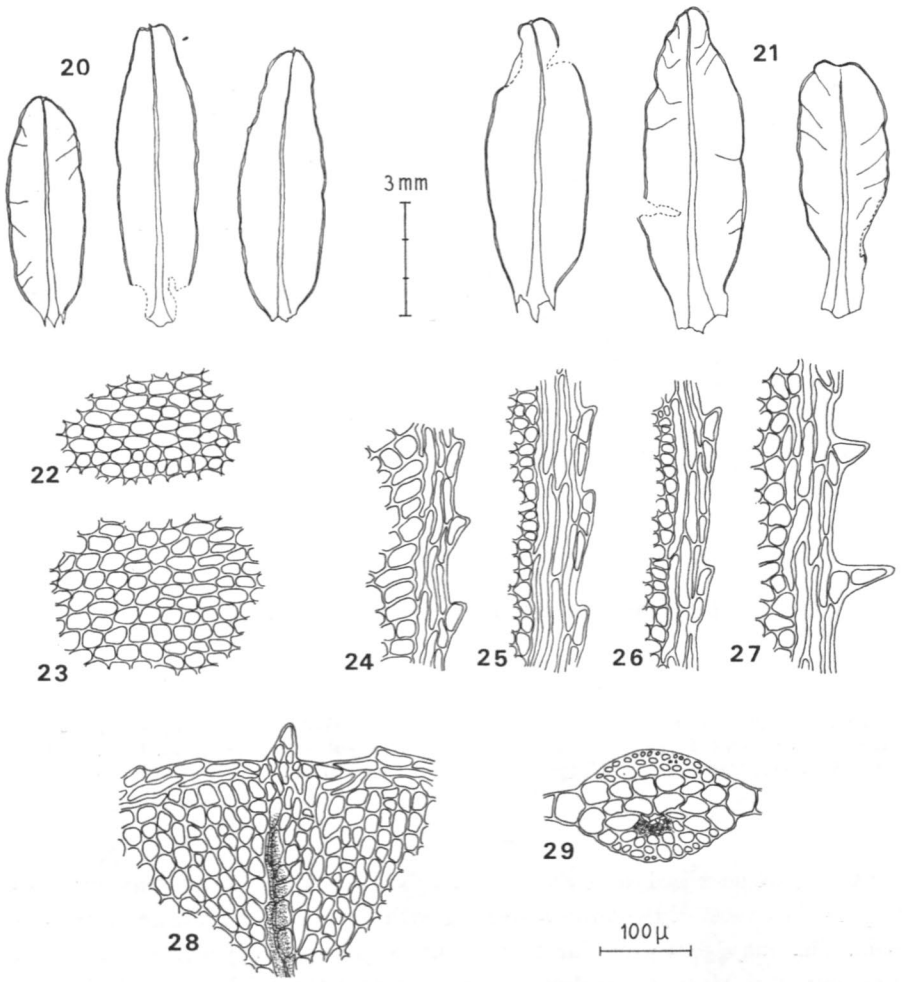
### *Distribution and ecology*

The main part of the material seen for this study came from Taiwan, India, especially from the Himalayas, and Thailand. Specimens from the Philippines, Java, Burma and Vietnam were seen. Thus, *P. rhynchophorum* obviously has a rather wide range in eastern tropical Asia. In Taiwan the species was collected at the altitude of 1100—2100 m and thus it inhabits lower zones than *P. maximoviczii*. The ecology is similar to that of *P. maximoviczii*, in that it occurs in woodlands on stones, rotten wood and on soil.

List of localities

Among the specimens listed in MITTEN (1859) all but J. D. Hooker 666 and Gardner 671 were seen (BM, H-SOL, NY) and belong to *P. rhynchophorum*, except Hooker & Thomson 662 which is *P. succulentum* (cf. p. 22). Specimens listed by NOGUCHI (1966) under *Mnium maximowiczii* belong here (NICH).

India. N. W. Himalaya: Sine loco, leg. Falconer (NY); Simla, leg. Beddom no. 1 (NY); Dehra-Dun, pr. Sansidara, 2—3000', 1891 Duthie (NY). — Darjeeling Distr.: Ghoom Ridge, 6800 p, 1900 Hartles (LEVIER, Bryotheca exotica 58, NY); Darjeeling, 1800—




FIGS. 20—29. *Plagiomnium rhynchophorum*. 20, 21 = leaf shapes. 22, 23 = lamina cells. 24, 26 = leaf border. 25, 27 = leaf border near apex. 28 = leaf apex. 29 = cross section of costa. — Figs. 20, 22, 25, 26 from Strachey & Winterbottom 46 (India, Kumaon herb. Hooker, BM). — Figs. 21, 23, 24, 28, 29 from the type of *Bryum coriaceum*. — Fig. 27 from HIRO 67271 (Thailand, leg. Yoda).

2200 m, 1961 Gangulee 5112, 5298, 5320 (HIRO); Ranbi forest near Darjeeling, 7400 ft. 1965 Iwatsuki, A. J. & E. Sharp 7934 (NICH); Mungpoo, 6000 ft., 1965 Iwatsuki, A. J. & E. Sharp 10374 (NICH); Tongloo, 10000 ft., 1965 Iwatsuki, A. J. & E. Sharp 9864 (NICH) above Kurseong, 5500 ft., 1965 Iwatsuki, A. J. & E. Sharp & 10812 (NICH). — Sikkim 5—7000', leg. Kurz 2176 (NY). — Assam: Khasi-Jaintia Hills, Shillong, 3000, 5000 and 6000 ft., 1965 Iwatsuki, A. J. & E. Sharp 7765, 7342, 8410 (NICH). — Himalaya or.: Brit Bootang, inter Maria Basti et Labar, 5—6000 p., 1898 Durel (Bryotheca E. Levier, det Brotherus no. 21, NY). — South India: Nilgiri Hills, leg. Beddom 428, 410, 141 (NY), leg Srinivasan (HIRO); Palni Hills, 7000 ft., 1956 Foreau (HIRO).

Nepal. Kenza, 1770 m, 1963 Yoda 11448 (TNS); Kakani, 2100 m, 1953 Nakao 86 (HIRO).

Bhutan. Leg. Griffith (NY, + *P. succulentum*).

Ceylon. Central Prov., sine coll., as *Mnium nietneri* C. Müll. (C. M. 125, H-BR); »am Hunasgiriaspik bei Kandy am Bäumen», 1200 m, 1898 Fleischer (= FLEISCHER, Musc. Frond. Arch. Ind. Polynes. 467, HIRO, NY); Jungle East of Haputale, 5200 p., 1900 Willis (Bryotheca E. Levier. det. Brotherus as *Mnium nietneri* sub. no. 1240, H-BR).

Borneo. Leg. Korthals (NICH).

Indonesia. Java, sine coll. (herb. Mitten, NY); »West-Jawa, im Berggarten von Tjibodas am Gedeh auf schattiger Erde», 1450 m, 1900 Fleischer (= FLEISCHER, Musci Arch. Indici 170, HIRO, NY); Prov. Preanger,» südl. Abhänge des Pangerango», 1894 Schiffner (= Crypt. exs. Mus. Hist. Nat. Vindobonensi 3975, NICH); Tjibodas, on dry soil in (*Altingia-Fagaceae-Lauraceae* mixed) forest 1400 m, 1967 Frodin (NICH).

Philippines. Luzon. Benguet subprovince, 1911 Merrill 7856 (NY); Mountain Prov., Mt. Data, 1946 Hoogstreal et al. (HIRO). — Specimens listed by IWATSUKI & SHARP (1968) as *Mnium maximoviczii* belong to *P. rhynchophorum* (NICH).

Burma. Moulmein, 6000 ft., leg. Parish 135 (NY); Webula, 1938 Dickason 7788 (+ *P. succulentum*, NICH); Taunggyi, 4500 ft., 1957 Egerod B-9 (NICH).

Thailand. Specimens listed by HORIKAWA & ANDO (1964) as *Mnium maximoviczii* are *P. rhynchophorum* (HIRO).

North Vietnam. Ad corticem in reservato pr. opp. Sapa, 1600 m, 1963 Pócs 2563/r (+ *P. succulentum*, NICH).

Taiwan. Cf. KOPONEN 1971d.

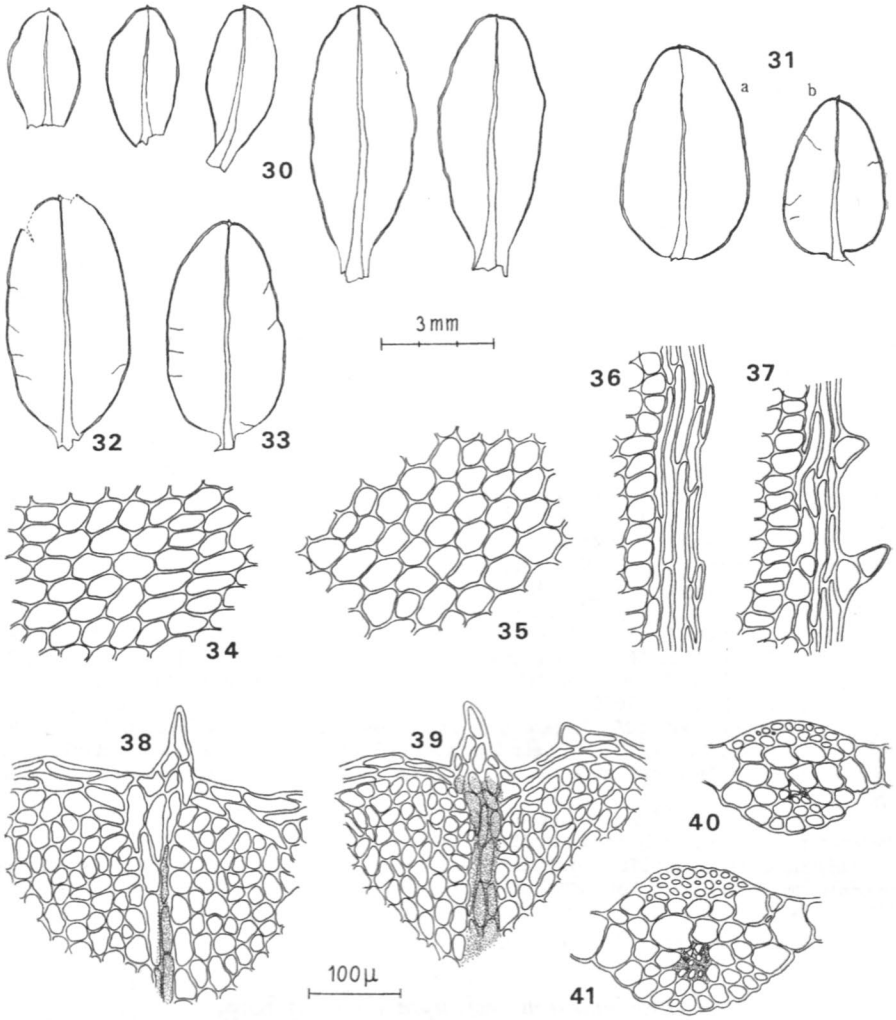
## *Plagiomnium integrum* (Bosch & Lac.) Kop.

(Figs. 30—41)

*Plagiomnium integrum* (Bosch & Lac.) Koponen, Hikobia 6: 57. 1971. — *Mnium integrum* v. d. Bosch & Lacoste in Dozy & Molkenboer, Bryol. Javanica 1: 153. 1860. — Holotype: Sumatra, Padang, leg. Wiltens (L, cf. KOPONEN 1971b).

### *Taxonomy*

Although described more than one hundred years ago, *P. integrum* has been neglected by most of the authors dealing with the moss flora of eastern tropical Asia. This may partly be due to FLEISCHER (1902—1904) who reduced it to a synonym of *Mnium succulentum*. The fact that the original description was based merely on male plants and sterile stolons, and that the female plant remained unknown, possibly influenced the missunderstanding of the species. KABIERSCH (1936), for instance, mentions only two specimens and one literature record of the taxon. Later the species was recognized by BARTRAM (1939) and VAN ZANTEN (1964). *P. integrum* has been confused with the other tropical and subtropical members of the group, namely *P. rhynchophorum* and *P. succulentum*. *P. rhynchophorum* can be separated from *P. integrum* by the smaller size and shape of the laminal cells, by the shape of leaves, and by the sexuality (cf. Table 1). *P. succulentum* differs by the less differentiated leaf border, costa not reaching apex, larger laminal cells, and larger leaves without decurrent leaf bases. Also sterile specimens can be separated through the vegetative characters mentioned. The leaves of the stolons of *P. integrum* are more broadly




FIGS. 30—41. *Plagiomnium integrum*. 30 = leaf spectrum. 31—33 = leaf shapes. 34, 35 = laminal cells. 36, 37 = leaf border. 38, 39 = leaf apex. 40, 41 = cross-section of costa. — Figs. 30 and 31 from the upright fertile stem and stolon of the same female plant, respectively. — Fig. 32 from male plant. — Figs. 33, 35, 36, 38, 40 from stolons. — Figs. 30, 31, 34, 37, 39, 41 from Koponen 16897 (Taiwan, Mt. A-li). — Figs. 32, 33, 35, 36, 38, 40 from the type of *P. integrum*.

elliptic than the leaves from female plants, and also the cell size is larger. Although leaves without teeth occur, those from stolons characteristically have scattered small projecting marginal teeth. — The differences between *P. integrum* and the species not mentioned above are discussed under these taxa.

*Distribution and ecology*

On the basis of the material studied, *P. integrum* seems to be distributed in tropical and subtropical parts of Eastern Asia. The range much resembles that of *P. succulentum*, but *P. integrum* has not been discovered in Japan. On the basis of field experience in Taiwan it can be stated that the species there inhabits higher altitudes than *P. succulentum*. It was found on stones and rotten wood in subtropical and temperate woodlands and was also recorded growing along woodland trails. The habitats could be described as mesic although due to the high precipitation the local differences in moisture content of microhabitats are not as pronounced as in the areas of drier climates (cf. KOPONEN 1971a: 386).

List of localities

India. N. W. Himalaya, Mussoorie Distr., in latere septentr. montis Nag Tiba, 10000', 1900 Bahadru (Bryotheca E. Levier sub. Brotherus no 4257, NY). — West Bengal. Darjeeling area, Ranbi forest near Darjeeling, 7400 ft., 1965 Iwatsuki, A. J. & E. Sharp 7915 (NICH); Chittre above Manebhanjang, 7800 ft., 1965 Iwatsuki, A. J. & E. Sharp 10239 (NICH). Sikkim, Darjeeling Distr., Ghoom Range, 6800', 1900 Hartless (Bryotheca E. Levier, sub. Brotherus 2252, NY); Yoksam — Praig Chu, 1960 Hara et al. (NICH).

Nepal. East Nepal, Ghatte — Khebang, 1600—2200 m, 1963 Hara et al. (NICH).

Burma. Hoka, 6200 ft., 1938 Dickason 7294 (NY).

Indonesia. »West-Jawa. Gedehgebirge am Wasserfall vor: Tjiburrum an triefenden Felsen zwischen anderen Moosen umherschweifend,» 1700 m, 1900 Fleischer (= FLEISCHER, Musc. Frond. Arch. Ind. 366, HIRO, NY); G. Gedeh-Pangerango, Tjibeuereum 1700 m, 1952 Meijer B3452 (NICH).

North Borneo. Foot of Mt. Kinabalu, between Sosopodon and S. Kelinggen, 1350—1400 m, 1963 Iwatsuki 1442a (NICH); near Hot Spring Poring, ca. 600 m 1963 Iwatsuki 1867 (NICH); between Hot Spring Poring and S. Langanan R., ca. 650 m, 1963 Iwatsuki 1765 (NICH).

Philippines. Luzon. Bontoc subprovince, 1911, 1912 Vanoverbergh 1060, 1775 (NY).— BARTRAM (1939) correctly recorded these specimens.

Taiwan. Chia-yi Co.: Mt. A-li. Valley on S-slope with open planted *Chamaecyparis formosensis* wood, on moist soil, 2300 m, 1970 Koponen 16897 (H).

## *Plagiomnium vesicatum* (Besch.) Kop.

(Figs. 42—55)

*Plagiomnium vesicatum* (Besch.) Koponen, Ann. Bot. Fennici 5: 147. 1968. — *Mnium vesicatum* Bescherelle, Ann. Sci. Nat. Bot. Ser. 7, 17: 345. 1893. — Holotype: »Nippon nord: montagne d'Aomori, septembre 1885 U. Faurie 1339» (BM, not seen; isotype in KYO).

*Mnium Kiyoshii* Okamura, J. College Sci. Imper. Univ. Tokyo 38(4): 19—20. 1916. — *Mnium rostratum* var. *Kiyoshii* (Okam.) Noguchi, J. Jap. Bot. 27: 31. 1952. — Holotype: Japan. Hondo: Prov. Izu, in monte Amagi, 18.VIII. 1914 Kiyoshi Fujii (NICH 37691).

*Mnium Osadae* Sakurai, Bot. Mag. Tokyo 49: 765—766. 1935. — *Mnium vesicatum* var. *Osadae* (Sak.) Sakurai, Musc. Jap. 82. 1954. — Holotype: Japan. Honshiu: Prov. Kotsuke, Shimonida, 14. Juli, 1932 T. Osada (= herb. K. Sakurai 4352, MAK, not seen; isotype in herb. Noguchi).

*Mnium spathulatulum* Sakurai, Bot. Mag. Tokyo 49: 769. 1935. — Holotype: Japan. Honshiu: Prov. Musashi, Chichibu, Mt. Mitsumine, Sept. 1932 K. Sakurai 4566 (MAK; isotype in herb. Noguchi).

*Mnium Doii* Sakurai, Bot. Mag. Tokyo 49: 770. 1935. — Holotype: Japan. Prov. Satsuma, Koriyama, auf feutchten felsen, 26.II.1922 Y. Doi (= herb. Sakurai 3118, MAK).

*Mnium tanegashimense* Sakurai, Bot. Mag. Tokyo 49: 772. 1935. — *Mnium vesicatum* var. *tanegashimense* (Sak.) Sakurai, Musc. Jap. 82. 1954. — Holotype: Japan. Prov. Ohsumi, insula Tanegashima, Hamatsubaki, 21.VI.1932 Y. Doi 778 (= herb. Sakurai 2745, MAK, not seen; isotypes in KYO and herb. Noguchi).

*Mnium vesicatum* var. *ellipticifolium* Thériot & Sakurai in Sakurai, Bot. Mag. Tokyo 49: 766. 1935. — Lectotype ? (cf. HATTORI & NOGUCHI 1960): Japan. Honsyu. Prov. Izu, Mt. Higane, April 1931 K. Sakurai 3767 (MAK, not seen; isosyntype, Sakurai 1570, in herb. Noguchi).

*Mnium vesicatum* var. *minor* Sakurai, Bot. Mag. Tokyo 49: 766. 1935. — Lectotype? (cf. HATTORI & NOGUCHI 1960): Japan. Honshiu: Prov. Bingo, Mt. Taishaku, Juni 1932 A. Noguchi (= herb. Sakurai 4304, MAK, not seen; isosyntype, leg. Uyeda, Jan. 1932, in herb. Noguchi).

## *Taxonomy*

Some puzzling taxonomic problems center around *P. vesicatum* which is the most variable taxon of the group. This variability is obviously due to its ecology (cf. below). Ecological modifications are most common in species growing in wet habitats; many *Drepanocladus, Calliergon* and *Sphagnum* species are well-known examples. Among the *Mniaceae, Plagiomnium ellipticum* shows a variability similar to that of *P. vesicatum* (cf. KOPONEN 1971c). In most cases well-developed plants of *P. vesicatum* which grew in habitats wet throughout the year can be determined without hesitation. The diagnostic characters of *P. vesicatum* are the elliptic leaves with decurrent bases, a pronounced border 30—50 $\mu$ wide and rather large thinwalled laminal cells without or with small corner thickenings. The costa is usually percurrent in upright stems but in leaves from stolons it often ends without reaching the apex. The dorsal epidermal layer of the costa in cross-section is without or with only slightly thickened walls, and the ventral epidermal layer may be more widecelled than in the other species. Leaves in dry specimens are characteristically reflexed which is a useful character and this is also visible in sterile shoots. The colour of dry specimens is often yellowish to brownish.

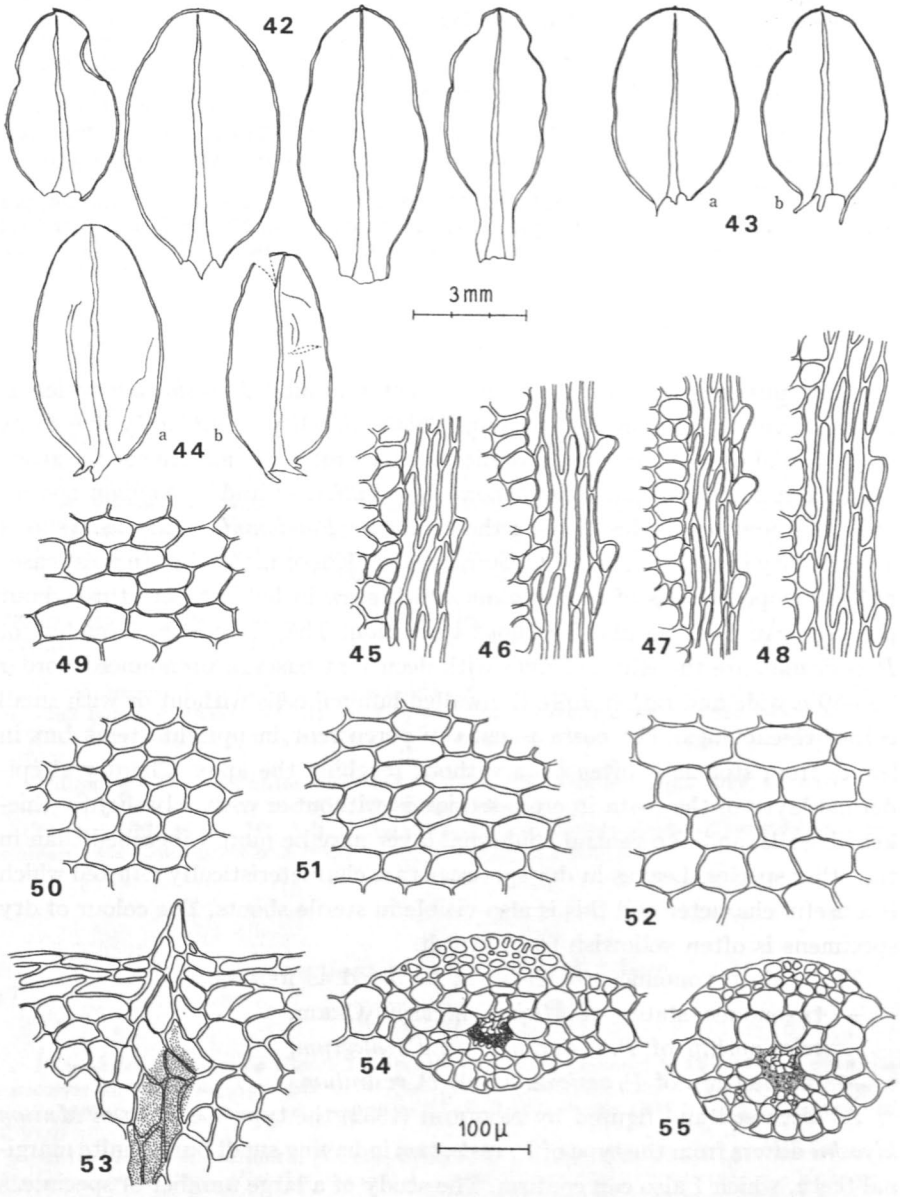
The main taxonomic problems can be listed as follows:

— taxonomic status of *Mnium kiyoshii* Okam.

— relationship of *P. vesicatum* and *P. integrum.*

— relationship of *P. vesicatum* and *P. rostratum.*

As discussed and figured by NOGUGHI (1952) the type specimen of *Mnium kiyoshii* differs from the type of *P. vesicatum* in having small but definite marginal teeth, which I also can confirm. The study of a large number of specimens and the comparison of sterile stolons and fertile stems of the same specimen (cf. p. 3), revealed that although the teeth are often absent on leaves from weakly developed stolons of *P. vesicatum*, they are only rarely completely absent on fertile material. Finally, it was concluded that the type specimen of *Mnium kiyoshii* represents well-developed stolons of *P. vesicatum.*




FIGS. 42—55. *Plagiomnium vesicatum*. 42—44 leaf shapes. 45—48 = leaf border. 49 — 53 = laminal cells. 53 = leaf apex. 54, 55 cross sections of costa. — Fig. 42 and 43 from upright stem and stolon of the same female plant, Figs. 52 and 49 show their laminal areolation, respectively. — Figs. 44, 45, 46, 48, 51, 54 from stolons. — Figs. 42, 43, 49, 52, 53, 55 from Koponen 12099 (Japan, Hokkaido). — Figs. 44a, b, 48, 51, 54 from the type of *P. vesicatum*. — Fig. 45 from the type of *Mnium osadae*. — Fig. 46 from the type of *M. kiyoshii*. — Figs. 47 and 50 from the type of *M. spathulatulum*.

The difficulty in separating *P. vesicatum* and *P. integrum* concern mainly sterile shoots. Fertile stems can be separated without hesitation even if ecological and phytogeographical differences are not considered (Table 1). *P. integrum* has a narrower leaf shape, coarser serrulation, smaller laminal cells with more thickened walls, and a narrower costa which has thicker cell walls in cross-section. Decurrent leaf bases are narrower and the leaves are not similarly reflexed in the dry state as the leaves of *P. vesicatum*. None of these characters are absolutely reliable in determining weakly developed sterile material, however, since a rather complete overlap exists in them. The most useful diagnostic character seems to be pronounced border in *P. vesicatum;* 30—50 $\mu$ wide compared with about 25 $\mu$ in *P. integrum*. In addition, the broad costa of *P. vesicatum* often ends below the apex while the narrower costa in *P. integrum* is percurrent in sterile shoots. The most problematic specimens are some weakly developed stolons of *P. vesicatum,* evidently collected in drier habitats than what is usual for the species. The cell size and corner thickenings in them are rather similar to *P. integrum* and the size and growth habit completely correspond to that species. In some cases I was able to confirm that these stolons originate from bases of fertile male stems of *P. vesicatum.*

The difficulties in separating *P. vesicatum* from *P. rostratum* are similar to the difficulties encountered when separating *P. vesicatum* from *P. integrum.* Fertile material can be separated on the difference in the sexuality, and by the different size and shape of laminal cells. Since the cell size tends to be larger in sterile stolons, some specimens of *P. rostratum* may be difficult to separate from poorly developed stolons of *P. vesicatum* described above. Small forms of *P. vesicatum* were frequently determined as *P. rostratum* in the herbaria. I could not find any discontinuities in their diagnostic characters when compared with the main stock of *P. vesicatum* which would suggest that these aberrations are not worthy of taxonomic rank.

### *Distribution and ecology*

*P. vesicatum* is a common species in Japan where it is distributed from Yakushima Island to northern Hokkaido. Its altitudinal range is wide as it grows both in lowlands and in the subalpine zone, roughly up to the middle oroboreal zone. Most commonly it seems to be in cool temperate (= upper orotemperate) and lower oroboreal zones. From outside Japan specimens from Korea have been seen which would suggest it has a wider distribution in temperate and southern boreal East Asia (cf. SAVICZ-LJUBITZKAJA & SMIRNOVA 1970). The records from Taiwan and the Himalayas should be confirmed.

The reason for the wide zonal amplitude and puzzling variability of *P. vesicatum* may be its ecology. Typical habitats are creek banks and cliffs with

trickling water in woodlands. Rather often it can be found submerged or forming loosely floating mats. The minor forms mentioned above seem to originate from drier habitats. The substratum is mostly rock, both silicaceous and calcareous, but it also grows on moist woodland soils. *P. vesicatum* also has been found to grow along woodland trails on soil.

Representative specimens studied:
Korea. Mt. Taebaeck, on wet rocks, 950—980 m, 1961 Hong 6414, 6416, 6428, 6429, 6430, 6431 (NICH); Mt. Sokri, on rocks, 350 and 550 m, 1960 Hong 2780, 2771, 2776 (NICH); Isl. Dagelet, 60, 400, 500 and 700 m, 1961 Hong 6152, 6157, 6155, 6154 (NICH).
Japan. Hokkaido. Ishikari Distr.: Sapporo -shi, Jozankei Nat. Forest, Omine. *Picea jezoensis — Alnus hirsuta* herb-grass swamp forest, on soil, 650 m, 1970 Koponen 12099 (H). — Musci Japonici exs. 116, 232, 282, 376, 987, 931 and Crypt. exs. Mus. Hist. Natur. Vindobonensi 4181 (NICH) are *P. vesicatum*.

## *Plagiomnium succulentum* (Mitt.) Kop.

(Figs. 56—70)

*Plagiomnium succulentum* (Mitt.) Koponen, Ann. Bot. Fennici 5: 147. 1968. — *Mnium succulentum* Mitten, J. Linn. Soc. Bot. Suppl. 1: 143. 1859. — Lectotype (cf. below): In Nepal orient. reg. temp. [Mai valley, 4000 ft.], leg. J. D. Hooker 680 (NY).

*Mnium formosicum* Cardot, Beih. Bot. Centralbl. 19(2): 112. 1905. — Holotype: Formosa. Kushaku, 6.VI.1903 U. Faurie s. no. (PC, not seen; isotype in KYO, = no. 147).

*Mnium Yakushimense* Cardot & Thériot in Thériot, Monde Pl. Sér. 2, 9(45): 22. 1907. — Holotype: Japon. Arch. Liu-Kiu, Yaku-Sima, 1898 P. Ferrié (PC, not seen; isotype NICH 37689).

*Mnium Nazeense* Cardot & Thériot in Thériot, Monde Pl. Ser. 2, 9(45): 22. 1907. — Holotype. Japon. Arch. Liu-Kiu, Naze, Nov. 1899 R. P. J. B. Ferrié (PC, not seen; isotype NICH 37692).

*Mnium luteo-limbatum* Brotherus, Sitzungsber. Akad. Wiss. Wien Math. Nat. Kl. Abt. 1, 131: 213. 1922. — Holotype: China. Hunan. Prope urbem Tschangscha in stillicidiis altus supra scolam montis Yolu-schan, alt. s.m. ca. 100 m, 21.II.1918 Dr. Heinr. Frh. v. Handel-Mazzetti 11488 (H-BR).

*Mnium* (*Serratae*) *Nakanishikii* Brotherus, Översikt Finska Vetenskaps-Soc. Förhandl. 62. Avd. A. 9: 21. 1920. — Lectotype (selected here): Japan. Shikoku: Prov. Tosa, Mt. Kuishi, I. 1904 H. Nakanishiki (3) 24 (H-BR).

*Orthomnium stolonaceum* Brotherus, Philipp. Journ. Sc. 3(1): 20. 1908. — Holotype: The Philippines, Camp Keithley, Lake Lanao, Mindanao, Jan. 1907 Clemens 36936—2 (H-BR).

*Mnium kawadei* Okamura in Matsumura, Icon. Pl. Koisikavenses 3: 37. 1916. — *Plagiomnium kawadei* (Okam.) Iwatsuki in Inoue & Iwatsuki, Bull. Nat. Sci. Mus. Tokyo 13: 488. 1970. — Type locality: Bonin (cf. below).

*Mnium integro-radiatum* Dixon, Hong Kong Natural. Suppl. 2: 17. 1933. — Type: Jai-Po, Hong Kong New Territories, leg. G. A. C. Herklots 247b (BM).

*Mnium succulentum* var. *integrum* Noguchi, J. Jap. Bot. 27: 32. 1952. — Holotype: Formosa. Prov. Taihoku. Rahau, Aug. 13, 1932 A. Noguchi 5909 (NICH 300074).

*Mnium rostratum* f. *laxirete* Kabiersch, Hedwigia 37: 46. 1936. — Lectotype (selected here): Khasia, Churra, 4000 f., leg. D. Hooker & Dr. Thomson 662 (NY).

*Note.* Kabiersch (1936) listed *Mnium Esquiroli* Card. & Thér., *M. subvesicatum* Broth. & Par. and *M. voxense* Besch. as synonyms of *M. succulentum*.

The specimen given as the lectotype of *P. succulentum* was mentioned as the type by Dixon (1912), although he found some taxonomic difficulties in it. Reimers (1931; cf. also Kabiersch 1936) stated that the specimen is a »typical» *Mnium succulentum*. The speci-

men in NY, herb. Mitten was the only one with sporophytes among the syntypes seen (cf. the list of localities).

The selection of the lectotype for *Mnium rostratum* f. *laxirete* Kabiersch is based on the fact that KABIERSCH (1936) figured the specimen in question and thus it possibly represents a typical plant.

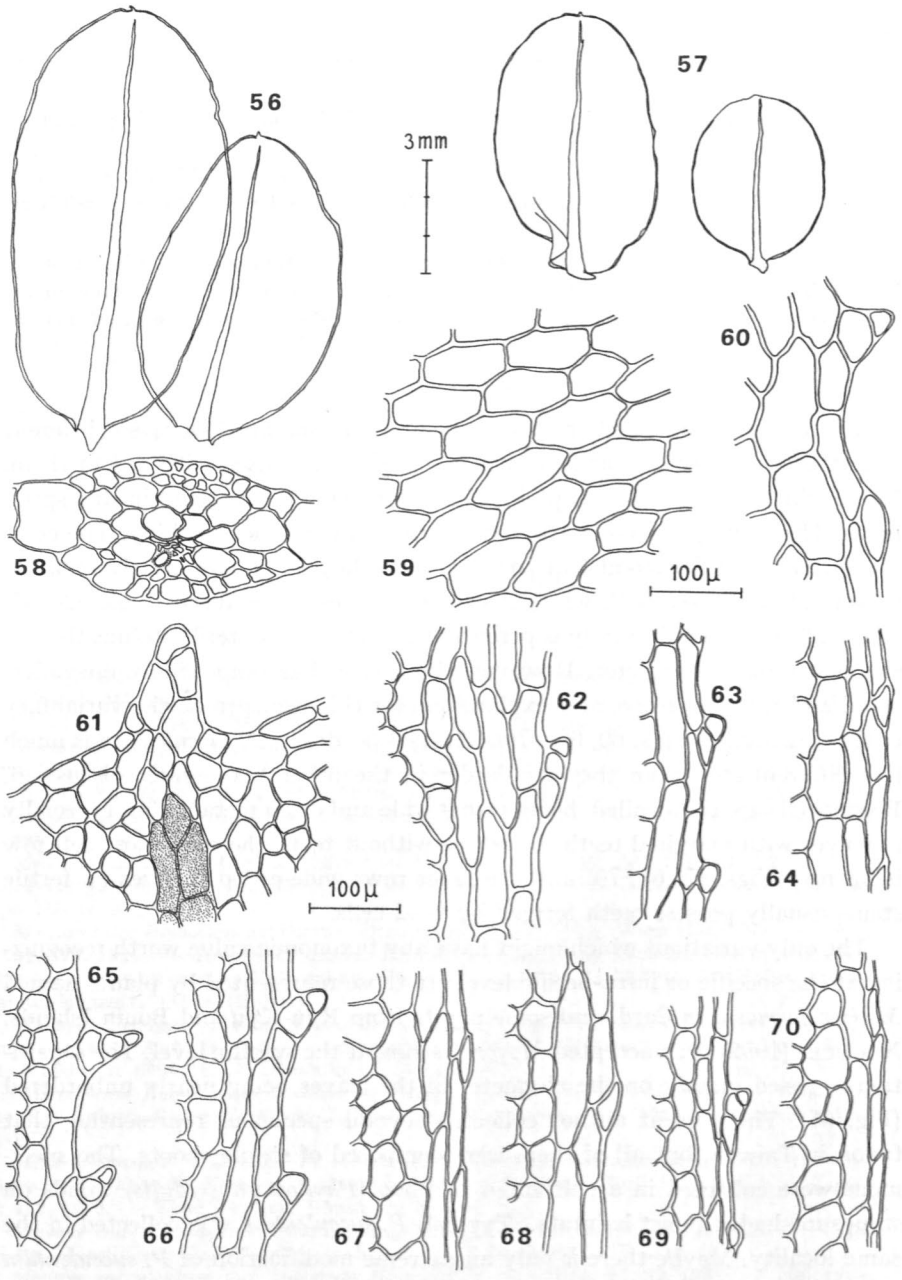
The type of *Mnium kawadei* was not studied. On the basis of the figures in the protologue this taxon is *P. succulentum*. Especially the figure showing the cross-section of the costa fits well. One specimen of *P. succulentum* from Bonin Islands was seen (cf. below).

## *Taxonomy*

The combination of characters present in *P. succulentum* is so different from the other species that it only rarely may be confused with any of them. Large, elliptic to broadly elliptic leaves often remain spreading in dry specimens. The leaves, as well as the stems, are characteristically shiny. The complete absence of decurrent leaf bases, and the larger cell size clearly separate it from *P. vesicatum*, with which it can sometimes be confused (Figs. 42—44, 56, 57). The costa only rarely is percurrent. Even in tiny sterile stolons the cell size is a reliable character. However, the species has been widely misunderstood and the only reasonable explanation for this seems to be the variability of the leaf border (Figs. 60, 62—70). The leaf border in *P. succulentum* is much less differentiated than the leaf border in the other taxa under discussion. Border cells are thin-walled, being rather wide and often rectangular, especially in leaves with marginal teeth. In leaves without teeth the outermost cell row is narrow (Figs. 67, 68, 70) and the inner rows wide-celled. Leaves on fertile stems usually possess teeth formed by 1—2 cells.

The only variations which might have any taxonomic value worth recognizing at the specific or infraspecific level are those represented by plants named *Mnium formosicum* Card. and some plants from Ryu-Kyu and Bonin Islands. NOGUCHI (1952) even accepted *M. formosicum* at the specific level. The separation is based mainly on the character of the leaves being nearly unbordered (Fig. 65). The present author collected several specimens representing that taxon in Taiwan, but all of them were composed of sterile shoots. The specimens were collected in a cultivated bamboo (*Phyllostachys edulis*) woods on stones in shaded moist habitats. »Typical» *P. succulentum* was collected in the same locality. Maybe there is only an extreme modification of *P. succulentum* in question, although this can be ascertained only after fertile material also has been studied.

SHIN (1962) recorded under *P. vesicatum* some specimens which on the basis of the characters of the costa, border, and nondecurrent leaves belong to *P. succulentum*. They differ from *P. succulentum* by having smaller laminal cells with more strongly thickened cell walls. Also, here may be an ecological modification in question since the specimens were mainly collected from »moist




FIGS. 56—70. *Plagiomnium succulentum*. 56, 57 = leaf shapes. 58 = cross-section of costa. 59 = laminal cells. 61 = leaf apex. 60, 62—70 = leaf border. — Figs 66 and 67 drawn from leaves of upright stem and stolon of the same female plant, respectively (Koponen 17592, Taiwan, Chi-tou). — Figs. 57, 64, 65, 68, 69, 70 from sterile stolons. — Figs. 56, 61 from the lectotype of *Mnium nakanishikii*. — Fig. 57 from the type of *Orthomnium stolonaceum*. — Figs. 58, 59, 60 from the lectotype of *Plagiomnium succulentum*. — Fig. 62 from the type of *Mnium luteo-limbatum*. — Figs. 63, 64 from the type of *M. yakushimense*. — Fig. 65 from the type of *M. formosicum*. — Fig. 68 from the type of *M. succulentum* var. *integrum*. — Fig. 69 from the type of *M. nazeense*. — Fig. 70 from Hattori 34 (Japan, Bonin Is., det. in herb. as *M. kawadei*).

sandstone». These plants seem to be identical with *Mnium kawadei* Okam. described from Bonin Islands. One specimen determined as *M. kawadei* in herbarium and collected in Bonin Islands showed to be similar to Shin's materials discussed above (cf. the list of localities).

### *Distribution and ecology*

*P. succulentum* has a wide distribution in tropical and subtropical Asia from Borneo to the Himalayas, and South China to Japan (cf. also IWATSUKI & SHARP 1968). In Japan its distribution area is restricted to the southern part of the country, in the area of evergreen temperate forest zone. *P. succulentum* seems to be rather dependant on the high moisture content of its habitats. On Kyushu and Honshu it was found only along streams and brooks, or on cliffs with trickling water. In Taiwan, and also on the Tokunoshima Island (NW of Okinawa) it is not restricted to habitats with running water but grows on stones on the forest floor of subtropical or temperate rain forest.

Specimens studied (cf. also KOPONEN 1971d):
Nepal. leg. Hooker 680 (= lectotype).
Bhutan. leg. Griffith (NY).
India. West Bengal: Darjeeling area, near Tung, above Kurseong, 5500 ft., 1965 Iwatsuki, A. J. & E. Sharp 10804 (NICH); Mungpoo, 6000 ft., 1965 Iwatsuki, A. J. & E. Sharp 10410, 10420 (NICH). — Assam: leg. Griffith (= syntype, NY), Kurz 1191 (NY); Khasia, leg. Griffith 163 (NY); Khasia Hills, leg. Griffith 165 (NY); In mont. Khasian, reg. temp., leg. J. D. Hooker & T. Thomson (= syntype, NY).
Burma. Webula, 1938 Dickason 7788 (+ *P. rhynchophorum*, NICH).
Thailand. Doi Inthanon, 1800—2000 m, 1958 Yoda (HIRO 67461, cf. HORIKAWA & ANDO 1964).
North Vietnam. Ad corticem in reservato pr. opp. Sapa, 1600 m, 1963 Pócs (+ *P. rhynchophorum*, NICH).
North Borneo. Foot of Mt. Kinabalu, between Sosopodon and S. Kelinggem, and near Kundasang. 1350—1400 m, 1963 Iwatsuki 1495, 1858, 1962 (NICH),
Philippines. Luzon: Benguet subprovince, 1911 Merrill 7870 (NY). — Specimens nos. 17498, 16357a and 14064 (NICH) listed in IWATSUKI & SHARP (1968) also seen.
Taiwan. Nan-tou Co.: Chi-tou Exp. Forest of Nat. Taiwan University. Planted *Cryptomeria japonica* — *Cunninghamia lanceolata* wood on NW slope, 1200 m, 1970 Koponen 17592 (H).
Japan. The specimens listed by BROTHERUS (1920) as *Mnium nakanishikii* and by SHIN (1961) as *M. vesicatum*, *M. succulentum* and *M. succulentum* var. *integrum* belong here (voucher specimens seen, except nos. 15303, 16099, 16162, 16456, 16465, 16474 and 16538). — Musci Japon. exs. 230.
Bonin Islands. Ogasawara Ids, Hahajima I., 1938 Hattori 34 (NICH, det. as *Mnium kawadei*).

## Doubtful and excluded taxa

*Mnium elimbatum* Fleischer ex Brotherus, Nat. Pflanzenfam. 1(3): 610. 1904 (15. Jan.). — [*Mnium elimbatum* Fleischer, Musci Fl. Buitenzorg. 2: 583. 1904 (April ?)]. — Syntype: Java, oberhalb Tjiburrum an Zweigen, 1800 m, VII. 1898 M. Fleischer (H-BR). — The validity of this species was doubted by REIMERS (1931) while KABIERSCH (1936) completely neglected it. The description seems to be based on two different elements;

*Orthomnion* cf. *loheri* Broth. and *Plagiomnium rhynchophorum*. The search of syntypes in FH gave a negative result but one of them (cf. above) belongs to *Orthomnion* (cf. *M. javense* below).

*Mnium excurrens* Paris & Brotherus in Paris, Rev. Bryol. 35: 127. 1908. — Holotype: China or., Zi Ka Wei, ad *Podocarpum macrophyllam* (Don), II. 1908 R. P. Courtois (H-BR). — KOPONEN (1971a) presented the opinion that the type could belong to a species of *Plagiomnium* sect. *Rostrata*. A restudy and comparison of the type revealed that it is a depauperate form of *Plagiomnium trichomanes* (Mitt.) Kop. The leaf border is completely without teeth but the leaf shape, acute apex, and cell shape and size connect the type to *P. trichomanes*.

*Mnium handelii* Brotherus, cf. KOPONEN 1968: 145.

*Mnium javense* Fleischer, Musci Fl. Buitenzorg 585. 1904. — Syntype: West-Jawa: Am Gedeh bei Tjibodas an Waldbäumen, 1400 m, Juli 1898 M. Fleischer (= FLEISCHER, Musci Frond. Arch. Ind. 310, HIRO). — Like *M. elimbatum*, *M. javense* has gained little attention among bryologists. Although BROTHERUS (1904) at first accepted it he later (1924) makes no mention of it. KABIERSCH (1936), who did not see the type, reported one specimen from Java which he stated to correspond completely with the description. However, REIMERS (1931) suggested that *M. javense* could be a species of *Orthomnion*. The present author saw one of the syntypes (cf. above) and it truly is a species of *Orthomnion*, or *Orthomniopsis*. It corresponds rather well to *Orthomnion loheri* Broth. (syntypes seen). On the basis of the description and figures, *Orthomniopsis elimbata* Nog. could belong here. However, BARTRAM (1965) claimed that the sporophyte of *O. elimbata* shows that it is a true *Orthomniopsis*. Therefore, I will leave the question open until the material seen by Bartram can be restudied, as well as the taxonomic status of *Mnium rotundifolium* Bartr. and *M. subelimbatum* Dix. evaluated (cf. also *Mnium elimbatum* above).

*Mnium spathulifolium* Dixon, J. Siam Soc. Nat. Hist. Suppl. 9: 23. 1932. — Holotype: Khun Tan Mts., Siam; 4000 ft. alt., 20 Nov. 1928 H. M. Smith 485 (BM). — The taxon is conspecific with *Orthomnion bryoides* (Griff.) Nork.

*Mnium subintegrum* Cardot, Beihefte Bot. Centralbl. 17: 19. 1904. — Holotype: Korea. Kang-Ouen-To, inter Lichenes parcissime, Juil. 1901 Faurie 47 (PC, not seen; isotype in KYO). — The isotype is a tiny specimen but can be determined to belong to *Plagiomnium trichomanes* (Mitt.) Kop. as was proposed by ANDO (1961).

## Summary

The six East Asiatic species of *Plagiomnium* sect. *Rostrata* (Kindb.) Kop. can be separated through different combinations of characters (Table 1). The most useful characters are the sexuality, leaf shape, and the absence or presence of decurrent leaf bases, the characters of the leaf border, and the shape and size of laminal cells.

*P. rostratum* (Schrad.) Kop. seems to be a discontinuously circumpolar temperate species. Asiatic specimens were seen from the Himalayas and west of China. It inhabits rather mesic or dry sites, such as limestone cliffs.

*P. maximoviczii* (Lindb.) Kop. has a wide distribution in temperate East Asia, while its close relative *P. rhynchophorum* (Hook.) Kop. is a tropical and subtropical species. These species have several characters in common which separate them from the other taxa and they possibly form a dioecious — synoecious species pair. Their ecology also is similar, both occurring on mesic sites in woodlands.

*P. integrum* (Bosch & Lac.) Kop. has a rather similar distribution to *P. rhynchophorum*, occurring in mountainous districts of tropical and subtropical Asia. Its closest relatives seem to be *P. rostratum* (cf. above) and *P. vesicatum* (Besch.) Kop., but its ecology, on soil and rotten wood in mesic conditions, separates them. *P. vesicatum* grows in wet or moist habitats in temperate to middle boreal zones. Its total range remains unknown but possibly includes, in addition to Japan and Korea, parts of mainland China and the Soviet Far East, such as the Sachalin and the Kuriles.

*P. succulentum* (Mitt.) Kop. has a wide range from the Himalayas to Japan in the east and at least to Borneo in the south. It is always easily recognizable through several unique characters, and it seems not to have any close Asiatic relatives. In the northern part of its range (Japan) it is rather limited to or near water but in the south (Taiwan) it grows on the forest floor on soil and stones.

## *Acknowledgements*

This research was carried out in the Institute of Botany, Faculty of Science, Hiroshima University. Assistance with field research was provided by staff members of the Hattori Botanical Laboratory, Nichinan, Japan, and Department of Botany, National Taiwan University, Taipei. I wish to express my sincere thanks to the staffs of these institutions for helping my research in many ways. I am indebted to the curators of the herbaria, and private persons (p. 3) who loaned specimens for my use, especially to Mrs. E. Sharp, Prof. A. J. Sharp and Dr. Z. Iwatsuki, who allowed me to use their extensive material collected during the Cooperative Hattori — Tennessee Bryogeographic Expedition. Dr. P. Isoviita and Mr. O. Vitikainen (Helsinki) and Dr. E. Nyholm (Stockholm) helped me in getting rare and old literature and Dr. C. C. Townsend (Kew) informed me of Wallich's herbarium. Prof. H. Ando (Hiroshima), Dr. R. R. Ireland (Ottawa), Dr. T. Ahti (Helsinki) and Dr. P. Isoviita (Helsinki) read the manuscript and offered valuable suggestions on it. Mrs. Aune Koponen, Cand Phil. drew the final copies of the figures. I wish to express my sincere gratitude to these persons.

This research has been aided by grants from the Japanese Ministry of Education, Finnish National Research Council for Sciences, and University of Helsinki, Finland.

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